DEPARTMENT OF GEOPHYSICS

STANFORD UNIVERSITY

STANFORD, CALIFORNIA

Annual Report No. 1

1 February 1966 - 31 January 1967

AFOSR Contract No. AF 49(638)-1687

Project Title: Seismological Analyses of VELA Array Data

ARPA Order No. 292-66

ARPA Project Code No. 8652

Date Contract Starts: 1 February 1966

Date Contract Terminates: 31 January 1968

Amount of Contract: $57,609

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1. Study of PKP Arrival Times in the 115° - 140° Epicentral Distance Range

Arrival times of PKP waves in the 115° - 140° epicentral dis-ance range as recorded at the VELA arrays, LRSM stations and SCGS world wide stations are being used to determine: (a) $^{dt}/_{d\Delta}$ or PKIKP arrivals in the 115° - 140° distance range and (b) $^{dt}/_{d\Delta}$ for PKHKP arrivals (the GH branch recently propo d by Bolt) in the 125° - 140° range.

Three criteria were used for the selection of earthquakes:

(a) occurrence in the time interval from 1 January 1965 - 30 June 1966 (but including readings from the deep-focus Java Sea earthquake of April 16, 1957);

(b) focal depths greater than 240 km;

(c) at least 10 readings of PKP for Δ<145° observed on the VELA and USCGS stations.

All available seismograms from eleven suitable earthquakes meeting the above criteria were examined. The numerical procedure used in the analysis of the data is the least square technique as developed by Jeffreys.

The preliminary value of $^{dt}/_{d\Delta}$ obtained for PKIKP in the $115° \leq \Delta \leq 140°$ range is 1.93 $\pm$ .03 sec/deg with a standard deviation for one observation of 1.3 seconds. This determination of $^{dt}/_{d\Delta}$ is very close to that obtained by Bolt in 1959 from an analysis of 24 selected southern earthquakes.

A least squares analysis of the observations of the precursors to PKIKP (PKHKP) tentatively lead to a linear relation with a

gradient of 2.26 ± 0.19 sec/deg with a standard error for one observation equal to 3.5 seconds. This value is somewhat lower than that predicted by Bolt's velocity model T2.

2. <u>The Energy of the Free Oscillations of the Earth</u>

A study has been made of the energies of the radial, torsional and spheroidal free oscillations for a Gutenberg model earth. Each mode of oscillation has a characteristic radial distribution of elastic and kinetic energy which fixes those parts of the earth that contribute most heavily in determining a particular resonant frequency. An examination of the partitioning of energy between compressional, shear and gravitational energy as a function of mode number and depth immediately explains the persistence of the purely radial mode compared to the other normal modes of the earth. Only the first few spheroidal modes are sensitive to the density of the inner core; they are particularly sensitive to the density of the outer part of the core. The low order spheroidal modes also exhibit a rapid rise of potential energy near the base of the mantle which will permit improved estimates of the velocity to be attained in this region difficult to examine with body waves.

The tabulated results allow estimates to be made of the previously neglected energy contained in the free oscillations excited by large earthquakes. An estimate of the energy in the low order spheroidal oscillations excited by the great Alaskan shock suggests a value of 10^{23} ergs over the period range from 450 to 830 seconds implying that the energy density increases toward high frequencies if the total energy in the earthquake was of the order of 10^{24}-10^{25} ergs. A paper entitled "Study of the Energy of the Free Oscillations

of the Earth" is in press in the Journal of Geophysical Research.

3. Attenuation of Seismic Body Waves in the Mantle and Core

Work is continuing on the difficult problem of measuring the attenuation of seismic body waves in the mantle and core. The technique being employed is spectral amplitude comparison of particular seismic phases that have the same vertical take-off angle in the mantle and have traveled the same great circle path.

Data from the VLLA Arrays and LRSM stations have been examined for suitable recordings of the seismic phases SKS and SKP. Spectral amplitude comparison allows the ratio of SKS to SKP to be put in the form

$$\ln\left[\frac{SKS}{SKP}\,\frac{C_p}{C_{sv}}\,\frac{F_p}{F_{sv}}\right] = -\pi f\left[\left(1-\frac{1}{1.82\eta}\right)\frac{T}{Q_\beta}\beta\right] + \text{constant}$$

where C_p and C_{sv} are frequency dependent crustal transfer functions, F_p and F_{sv} are frequency dependent core-mantle transfer coefficients (if a transition layer is assumed), f is frequency, T is travel time, η is Q_α/Q_β the ratio of dimensionless quality factors, and α and β are the average compressional and shear velocities in the mantle. The source function and geometric spreading are not involved.

The New Zealand shock of 8 Dec 65 [18h 05m 26.1s, H = 165 km] generated an exceedingly sharp long period SKP phase at Houlton, Maine (Δ = 131.5) and a clear SKS phase at Kansas City, Missouri.

After correction for the crustal transfer function the spectral ratio of SKS/SKP yields a maximum upper bound of 500 for the quality factor for shear over the frequency band from 0.035 to 0.055 Hz. Because of the steepness of the angle of incidence in

the core and the frequency band considered, it can be shown that for any reasonable assumed mantle-core transition layer that there is no spectral distortion introduced. Work is proceeding to expand the frequency range of data being examined. Papers presenting some preliminary results were presented at the UMC Symposium on Non-Elastic Processes in the Mantle and the Third International Symposium on Geophysical Theory and Computers.